WHAT IS CLAIMED IS:

1. A microfluidic device comprising:

a body structure comprising an elastomeric polymer substrate;

a microfluidic channel disposed within said elastomeric polymer substrate;

a port on a surface of said body structure and in fluid communication with said microfluidic channel for introducing or dispensing a fluid to or from said microfluidic channel; and

a means for transporting the fluid to and from said microfluidic channel.

2. The microfluidic device of Claim 1, wherein said elastomeric polymer substrate has a Young's modulus of about 3 MPa or less.

3. The microfluidic device of Claim 1 further comprising at least one valve system which comprises:

a control channel disposed within said elastomeric polymer substrate; and

one or more valves operatively connected to said microfluidic channel to regulate fluid flow through said microfluidic channel, wherein each of said valves comprises a portion of said elastomeric polymer substrate that is located between said control channel and said microfluidic channel, and wherein each of said valves is capable of being deflected into or retractable from said microfluidic channel upon which said valve operates in response to an actuation force applied to said valve, said valve when positioned in said microfluidic channel is capable of affecting fluid flow therethrough.

4. The microfluidic device of Claim 3 further comprising a pair of valve systems operatively disposed with respect to one another such that when the each valve of the pair of valve system extends into the microfluidic channel a holding space is formed between the valves in which the fluid can be retained.

5. The microfluidic device of Claim 3, wherein said means for transporting the fluid comprises a fluid pump comprising at least one of said valve system.

6. The microfluidic device of Claim 5, wherein said fluid pump comprises a single control channel.

7. The microfluidic device of Claim 6, wherein said fluid pump comprises one valve, and wherein the tip of said fluid pump control channel is tapered.

8. The microfluidic device of Claim 7, wherein said fluid pump control channel further comprises at least one capacitor which is capable of delaying actuation of said control channel.

9. The microfluidic device of Claim 6, wherein said fluid pump comprises a plurality of said valves.

10. The microfluidic device of Claim 9, wherein said control channel of fluid pump is interdispersed with at least one normally closed valve system.

11. The microfluidic device of Claim 9, wherein said control channel of fluid pump is interdispersed with at least one constricted region.

12. The microfluidic device of Claim 5, wherein said fluid pump comprises a plurality of said valve systems.

13. The microfluidic device of Claim 5, wherein said fluid pump is capable of providing a relatively constant fluid flow rate of about 0.02 μL/min or less.

14. The microfluidic device of Claim 3, wherein said valve system is actuated by pneumatic, electrostatic, piezoelectric, thermal or magnetic means.

15. The microfluidic device of Claim 3, wherein said microfluidic channel is an integrated microfluidic channel comprising at least first and second intersecting microscale fluidic channels, and wherein said first microscale fluidic channel is in fluid communication with said port.

16. The microfluidic device of Claim 1, wherein said body structure further comprises an elongated capillary protuberance, and wherein said port is disposed on or near the tip of said elongated capillary protuberance.

17. The microfluidic device of Claim 16 further comprising a plurality of said ports and said elongated capillary protuberances, and wherein each of said ports is disposed on or near the tip of each of said elongated capillary protuberances.

18. The microfluidic device of Claim 1, wherein said microfluidic channel is tapered towards said port.

19. The microfluidic device of Claim 1, wherein said port further comprises a capillary element comprising a capillary channel disposed therethrough, wherein at least one end of said capillary element is inserted into said port and positioned such that said capillary channel is in fluid communication with said microfluidic channel.

20. The microfluidic device of Claim 19, wherein said body structure comprises a plurality of said ports and a plurality of said capillary elements, each of said ports having each of said capillary elements inserted thereto.

21. The microfluidic device of Claim 19, wherein the diameter of said port is substantially greater than the diameter of said microfluidic channel.

22. The microfluidic device of Claim 21, wherein said capillary element is inserted into said port.

23. The microfluidic device of Claim 22, wherein said capillary element is removably attached to said elastomeric polymer substrate.

24. The microfluidic device of Claim 1, wherein said body structure comprises a plurality of said ports.

25. The microfluidic device of Claim 1, wherein said body structure further comprises:

a passageway defining an interstitial surface and which extends from a first surface to a second surface of said body structure; and wherein said port is disposed within said interstitial surface.

26. The microfluidic device of Claim 1, wherein said means for transporting the fluid comprises a vacuum device attached to a second port located within said body structure and which is in fluid communication with said microfluidic channel, whereby operation of said vacuum device introduces the fluid into the microfluidic channel through the port.

27. The microfluidic device of Claim 1, wherein said means for transporting the fluid comprises a pressurizing device operatively connected to said microfluidic channel, wherein said pressurizing device is attached to a fluid container such that when said port is in contact with the fluid and the fluid container is pressurized by the pressurizing device the fluid flows from the fluid container into the microfluidic channel.

28. The microfluidic device of Claim 1, wherein said microfluidic channel further comprises a narrow section that is capable of preventing further introduction of the fluid into said microfluidic channel when the fluid reaches said narrow section.

29. A microfluidic device comprising:

(a) a body structure comprising an elastomeric polymer substrate;

(b) a microfluidic channel disposed within said elastomeric polymer substrate;

(c) a fluid inlet in fluid communication with said microfluidic channel; and

(d) a fluid pump for introducing or dispensing a fluid to or from said microfluidic channel through said port, wherein said fluid pump comprises:

(i) a fluid pump control channel disposed within said elastomeric polymer substrate; and

(ii) one or more pump valves operatively connected to said microfluidic channel to regulate fluid flow through said microfluidic channel, wherein each of said pump valves comprises a portion of said elastomeric polymer substrate that is located between said fluid pump control channel and said microfluidic channel, and wherein each of said pump valves is capable of being deflected into or retractable from said microfluidic channel upon which said fluid pump valve operates in response to an actuation force applied to said fluid pump control channel, said fluid pump valve when positioned in said microfluidic channel is capable of affecting fluid flow therethrough.

30. The microfluidic device of Claim 29 further comprising a control valve system which comprises:

a control channel disposed within said elastomeric polymer substrate; and

a control valve operatively connected to said microfluidic channel to regulate fluid flow through said microfluidic channel, wherein said control valve comprises a portion of said elastomeric polymer substrate that is located between said control channel and said microfluidic channel, and wherein said valve is capable of being deflected into or retractable from said microfluidic channel upon which said valve operates in response to an actuation force applied to said control channel, said valve when positioned in said microfluidic channel is capable of restricting fluid flow therethrough.

31. The microfluidic device of Claim 29, wherein said fluid pump comprises one fluid pump channel.

32. The microfluidic device of Claim 31, wherein said fluid pump channel comprises a plurality of capacitors which are capable of delaying actuation of said fluid pump control channel.

33. The microfluidic device of Claim 29, wherein said fluid pump comprises a plurality of said fluid pump channels.

34. The microfluidic device of Claim 29, wherein said fluid inlet comprises an elongated capillary protuberance having a capillary channel disposed therethrough, wherein said capillary channel is in fluid communication with said microfluidic channel.

35. The microfluidic device of Claim 29, wherein said fluid inlet comprises a capillary element comprising a capillary channel disposed therethrough, wherein said capillary channel is in fluid communication with said microfluidic channel.

36. A method for sampling a fluid comprising:

(a) providing a microfluidic device which comprises:

(i) a body structure comprising an elastomeric polymer substrate;

(ii) a microfluidic channel disposed within said elastomeric polymer substrate;

(iii) a fluid inlet in fluid communication with the microfluidic channel for introducing a fluid into the microfluidic channel; and

(iv) a means for introducing the fluid sample into the microfluidic channel,

(b) contacting the fluid inlet with the fluid sample; and

(c) introducing at least a portion of the fluid sample into the microfluidic channel using the fluid introducing means.

37. The method of Claim 36, wherein the microfluidic device further comprises at least one valve system, wherein each valve system comprises:

a control channel disposed within said elastomeric polymer substrate; and

one or more valves operatively connected to said microfluidic channel to regulate fluid flow through said microfluidic channel, wherein each of said valves comprises a portion of said elastomeric polymer substrate that is located between said control channel and said microfluidic channel, and wherein each of said valves is capable of being deflected into or retractable from said microfluidic channel upon which said valve operates in response to an actuation force applied to said control channel, said valve when positioned in said microfluidic channel is capable of affecting fluid flow therethrough.

38. The method of Claim 37, wherein the means for introducing the fluid into the microfluidic device comprises a fluid pump comprising at least one of the valve system.

39. The method of Claim 36, wherein the microfluidic channel further comprises a narrow section, wherein a significantly higher force is required to introduce the fluid into the narrow section compared to the other section of the microfluidic channel.

40. The method of Claim 39, wherein the fluid is introduced into the microfluidic channel with the amount of force that is less than the amount of force required to introduce the fluid into the narrow section of the microfluidic channel.

41. The method of Claim 36, wherein the fluid inlet comprises a capillary element attached to said body structure, and wherein the capillary element comprises a capillary channel disposed therethrough and in fluid communication with the microfluidic channel.

42. The method of Claim 36, wherein the fluid inlet comprises an elongated capillary protuberance disposed within the body structure, and wherein the elongated capillary protuberance comprises a capillary channel which is in fluid communication with the microfluidic channel.

43. The method of Claim 36, wherein the means for introducing the fluid into the microfluidic device comprises using an external device which is operatively connected to a microfluidic channel.

44. The method of Claim 43, wherein the external device is a vacuum device which is operatively connected to an orifice disposed within the body structure, wherein the orifice is in fluid communication with the microfluidic channel.

45. The method of Claim 43, wherein the external device is a pressurizing device operatively connected a fluid container containing the fluid, said method for introducing the fluid sample into the microfluidic channel comprising:

contacting the fluid inlet with the fluid sample and pressurizing the sealed fluid container using the pressurizing device such that the fluid flows from the fluid container into the microfluidic channel.

46. A method for dispensing a fluid from a microfluidic device comprising:

a body structure comprising an elastomeric polymer substrate;

a microfluidic channel disposed within the elastomeric polymer substrate and comprising the fluid therein;

a fluid outlet in fluid communication with the microfluidic channel for dispensing the fluid from the microfluidic channel; and

a pump disposed within the elastomeric polymer substrate and operatively connected to the microfluidic channel such that fluid flow through the microfluidic channel can be regulated by the pump,

said method comprising dispensing the fluid from the microfluidic channel using the pump.

47. The method of Claim 46, wherein the microfluidic device further comprises at least one valve system, wherein each valve system comprises:

a control channel disposed within the elastomeric polymer substrate; and

one or more valves operatively connected to the microfluidic channel to regulate fluid flow through the microfluidic channel, wherein each of the valves comprises a portion of the elastomeric polymer substrate that is located between said control channel and the microfluidic channel, and wherein each of the valves is capable of being deflected into or retractable from the microfluidic channel upon which the valve operates in response to an actuation force applied to the control channel, the valve when positioned in the microfluidic channel is capable of affecting fluid flow therethrough.

48. The method of Claim 47, wherein the pump comprises one or more valve systems.

49. The method of Claim 48, wherein the fluid is dispensed through the fluid outlet that is disposed within an interstitial surface defined by a passageway that extends from a first surface to a second surface of the body structure.

50. The method of Claim 49, wherein the fluid dispensed into the passageway is held within the passageway due primarily to capillary action and/or surface tension.

51. The method of Claim 49 further comprising introducing a second fluid into the passageway to remove the fluid from the passageway.

52. The method of Claim 48 further comprising dispensing the fluid sample from the microfluidic channel into a sample holder.

53. The method of Claim 52, wherein the microfluidic device comprises a plurality of fluid outlets and the sample holder comprises a plurality of sample holding chambers.

54. The method of Claim 48, wherein the fluid outlet comprises an elongated capillary protuberance disposed within the body structure, and wherein the

elongated capillary protuberance comprises a capillary channel which is in fluid communication with the microfluidic channel.

55. The method of Claim 48, wherein the fluid outlet comprises a capillary element attached to the body structure, and wherein the capillary element comprises a capillary channel disposed therethrough and in fluid communication with the microfluidic channel.

56. The method of Claim 48, wherein each actuation of the pump dispenses a predetermined amount of the fluid sample.

57. The method of Claim 48, wherein the pump comprises a plurality of valve systems.

58. The method of Claim 48, wherein the microfluidic channel is an integrated microfluidic channel comprising at least first and second intersecting microscale fluidic channels, wherein the first microscale fluidic channel is in fluid communication with the fluid outlet.

59. The method of Claim 58, wherein the microfluidic device further comprises a pair of valve systems operatively disposed with respect to one another such that when the each valve of the pair of valve system extends into the microfluidic channel a holding space is formed between the valves in which the fluid can be retained.

60. The method of Claim 59 further comprising placing a predetermined amount of the fluid within the holding space and removing the excess fluid from the microfluidic channel prior to dispensing the fluid.

61. A method for producing a microfluidic fluid sampling device, said method comprising:

producing a first elastomeric layer comprising a top surface, a bottom surface and an orifice;

producing a second elastomeric layer comprising a top surface, a bottom surface and a microscale recess disposed on the bottom surface;

attaching the bottom surface of the first elastomeric layer on to the top surface of the second elastomeric layer;

creating an orifice on the second elastomeric layer such that the orifice on the first elastomeric layer becomes operatively connected to and in fluid communication with the microscale recess located on the bottom surface of the second elastomeric layer; and

attaching a base layer to the bottom surface of the second elastomeric layer, thereby forming a microfluidic channel from the microscale recess, wherein the microfluidic channel is disposed within the interface of the second elastomeric layer and the base layer.

62. The method of Claim 61, wherein the base layer comprises an orifice such that when the base layer is attached to the bottom surface of the second elastomeric layer the orifice on the base layer is in fluid communication with the microfluidic channel that is formed on the interface of the second elastomeric layer and the base layer.

63. The method of Claim 62 further comprising attaching a capillary element, which comprises a capillary channel disposed therethrough, to the microfluidic device by inserting the capillary element into the orifice on the first elastomeric layer or the bottom layer such that the capillary channel is in fluid communication with the microfluidic channel.

64. The method of Claim 61, wherein the first elastomeric layer comprises a second orifice, and said method further comprising creating a second orifice on the second elastomeric layer prior to attaching the base layer to the second elastomeric layer, such that the second orifice on the first elastomeric layer becomes operatively connected to and in fluid communication with the microscale recess located on the bottom surface of the second elastomeric layer.

65. The method of Claim 64 further comprising attaching a capillary element, which comprises a capillary channel disposed therethrough, to the microfluidic device by inserting the capillary element into one of the orifices on the first elastomeric layer such that the capillary channel is in fluid communication with the microfluidic channel.

66. The method of Claim 61, wherein the first elastomeric layer further comprises a microscale recess on the bottom surface such that when the bottom surface of

the first elastomeric layer is attached to the top surface of the second elastomeric layer, the microscale recess on the bottom surface of the first elastomeric layer forms a control channel disposed within the interface of the first elastomeric layer and the second elastomeric layer.